cupying waters. If one take a number of chemical solutions in the laboratory, and dump them together in a beaker, probably precipitation will occur. These conditions are precisely those of underground solutions in trunk channels. The water from one source meets the water from another source in the trunk channels. Analyses show that waters from different sources have different compositions. They bear different metals and precipitating agents. When they come together in the trunk channels, and mingle, precipitation is likely to take place. You, who are practical mining men, like your veins to intersect, or two veins to unite. The explanation of the frequent increased values at or adjacent to an intersection is simply that the different trunk channels bear solutions of different kinds, and when they mingle at or near the intersections, ore precipitation is likely to occur. One solution may bear its mite of silver or gold, and the other the precipitating agent, or both solutions may carry the metals, and when the two come together the ore be thrown down. However, this is not the only way in which precipitation may take place. In many instances the precipitation is due to the wall rock. The wall rock, or the solutions furnished by it, react upon the solutions coming from somewhere else, and precipitation occurs. These two causes for precipitation are not the ones which are ordinarily mentioned in treatises on ore deposits. The causes commonly assigned in text-books for precipitation are the diminishing temperature and pressure of the rising solutions. While these are real causes for precipitation, I believe them to be subordinate to the influence of the mingling of solutions from various sources in the trunk channels, to the influence of the wall rocks, and especially to the first. C. R. VAN HISE.

(To be concluded.)

THE PHYSICAL SCIENCES AT THE BRITISH ASSOCIATION.

THE meeting last September at Glasgow, which was attended by nineteen hundred persons, was smaller than the last two meetings held in that city, and fell slightly below the average of the British Association gatherings. This was chiefly the result of the unexpectedly small number of local associate members enrolled, accounted for by the fact that an International Exhibition with several collateral congresses had satisfied whatever desire the inhabitants of the Scotch metropolis may have had to increase their knowledge of scientific matters. The foreigners numbered only twenty-one, but some who might have attended this meeting had already been in Glasgow early in the summer as delegates to the jubilee celebration of the University. Since the president of the Association this year is one of the most distinguished physicists in Great Britain, it was natural to expect a large gathering of workers in his branch of science, but here also certain well-known names were missed from the list of members, which may likewise be attributed to the above cause. The meetings of all the sections were very conveniently held in the splendid University buildings on Gilmore Hill, the Physical Section holding its sessions in the Natural Philosophy Class Room, rendered famous by Sir William Thomson, now Lord Kelvin. The only criticism that could be made of the local arrangements was the absence of notices at the doors of each section indicating what paper was being read, but the same complaint has frequently been heard at our American Association meetings.

Professor Rücker's presidential address, which has already appeared in SCIENCE, was a scholarly defense of the atomic theory of matter, but some disappointment was manifested that the objections of its opponents were not definitely stated. Lord Kelvin, who seconded the vote of thanks to the

speaker by a short address of his own (as is customary in England), was rather bitter in his denunciation of those who did not accept the theories advanced. Hence it seems doubtful if the popular audience carried away a fair appreciation of the question. The two evening lectures were noteworthy because given by men whose names are household words in the scientific world. Professor Ramsay's topic was 'The Inert Constituents of the Atmosphere,' and though the unfortunate failure of the light prevented some of his diagrams from being visible at the proper time, the lucid explanations made the discourse entirely intelligible. Especially interesting was the description of the long and painstaking experiments and researches which resulted in the famous discovery of argon in 1894, followed in 1895 by that of helium, and in 1898 by that of three other elements to which the names of neon, krypton and xenon were applied. The second lecture, on 'The Movements of Plants,' by Mr. Francis Darwin, was a beautifully simple exposition of a most abstruse subject, namely, how gravity acted to force plants to grow along vertical lines. While the lecturer thought that plants might be classed as vegetable automata, yet he was inclined to believe that mind was always implicated in life, and that, with a fuller knowledge of consciousness, we should admit that the rudiments of the psychic element existed even in plants. There follows an abstract of the presidential addresses and of the work of the Sections of Mathematics and Physical Science, Chemistry and Engineering.

MATHEMATICS AND PHYSICAL SCIENCE.

The president of this Section was Major P. A. MacMahon, F.R.S., and his address dealt first with the position that mathematical science occupied at the beginning of the nineteenth century in the British Isles and on the continent of Europe. As regards organization and cooperation in mathematics, Germany, he thought, stood first now. The illustration offered by international cooperation in astronomy afforded a useful object lesson to all men of science, and might encourage those who had the ability and the opportunity to make strenuous efforts to further progress by bringing the work of many to a single focus. In pure science a free interchange of ideas was possible, but in applied physics the commercial spirit exercised an influence, and it was the duty of the Association to take an active attitude toward this blot on the page of applied science. The importance of science teaching in secondary schools had been overlooked. Those concerned in our industries had not seen the advantage of treating their workshops and manufactories as laboratories of research, and the Government had given too meager an endowment to scientific institutions and had failed adequately to encourage scientific men. At the present time, the number of workers is so large, the treatises and scientific journals so numerous, the ramifications of investigations so complicated that it was scarcely possible to acquire a competent knowledge of the progress being made in the many divisions of science. Hence the so-called specialist has come into being, and the word was often used as a term of opprobrium or as a symbol of narrow-mindedness. What is required is not the disparagement of the specialist, but the stamping out of narrow-mindedness, and of ignorance of the nature of the scientific spirit and of the life-work of those who devote their lives to scientific research. The specialist who wishes to accomplish work of the highest excellence must be learned in the resources of science and have constantly in mind its grandeur and its unity. Lord Kelvin and Professor Rücker offered the motion for a vote of thanks, and then the regular work of the

Section was begun. Papers were read by Professors A. Gray, F.R.S., J. S. Dunlop and A. Wood, on 'Elastic Fatigue as shown by Metals and Woods'; by Professor G. Quincke, of Heidelberg, on 'The Clearing of Turbid Solutions and the Influence of Light on the Motion of the Suspended Particles'; by Professor A. Gray, F.R.S., on 'The Relation between Temperature and Internal Viscosities of Solids'; by Professor W. Ramsay, F.R.S., and G. Senter, on 'Hydrostatic Pressure'; by E. H. Griffith, F.R.S., on 'The Freezing Points of Certain Dilute Solutions'; and by Dr. R. T. Glazebrook, F.R.S., on 'The Buildings of the National Physical Laboratory.' Dr. Glazebrook, who is the director of this new institution, gave a history and description of the building now being fitted up in Bushy Park, ten miles southwest of London, and described the objects for which it had been founded, as reported on pages 662–663 of SCIENCE.

On September 13 the Section was divided into two parts, Physics and the newly organized subsection of Astronomy. In the former Dr. Glazebrook read the report of the Committee on Electrical Standards, which stated that no evidence of any marked change in the relative values had shown itself. Mr. S. Skinner read a note on 'A Comparison of the Deposits in Silver Voltameters with different Solvents,' and Professor A. Schuster, F.R.S., presented one on 'The Conduction of Electricity through Mercury Vapor.' Dr. V. Crémieu, of Paris, spoke on 'The Magnetic Effects of Electric Convection' in which he showed that an electrically-charged body in motion has not the same electromagnetic properties as an electric current, but, as Lord Kelvin remarked, if these experiments are regarded as conclusive the present electromagnetic theory must be rejected. Other papers were by G. M. Minchin, F.R.S., on 'Photoelectric Cells'; by B. Hopkinson, on 'The Necessity for Postulating an Ether'; and by Professor F. C. Bose, on 'The Change of Conductivity of Metallic Particles under Cyclic Variations of Electromotive Force.' The Astronomical subsection met under the presidency of Professor H.H.Turner, F.R.S., of Oxford (who took the place of Dr. Copeland, Astronomer Royal for Scotland, detained by illness), and he delivered an address on cooperation in astronomical work, with special reference to the astrographic chart. While agreeing with Major MacMahon as to the value of cooperation, Professor Turner called attention to the harm that might result from undertaking too much and through the checking of original research. The most important astronomical papers were by Professor G. Forbes, F.R.S., on 'The Position of a Planet beyond Neptune,' and by Father A. L. Cortie, of Stonyhurst, who proved that the faculæ on the sun's surface followed the same law of drift as the spots. Professor Turner exhibited a copy of the first photograph of the spectrum of a lightning flash obtained by Professor E. C. Pickering, of Harvard Observatory.

At the next meeting of the Physical Section two papers, by Professor E. W. Morley and Mr. C. F. Brush, of Cleveland, were presented by the former gentleman, the first being on a new gauge for small pressures, designed especially to measure the pressure of aqueous vapor (which will be described in the *American Journal of Science*), and the second on the transmission of heat through water vapor. Other papers were by Messrs. C. Bedford and C. F. Green on 'A Method of Determining Specific Heats of Metals at Low Temperatures'; by Professor H. L. Callandar, F.R.S., on 'The Variation of the Specific Heat of Water'; two papers on the Lippmann electrometer by Messrs. F. G. Cottrell and J. A. Craw and one by Dr. M. W. Travers and G. Senter on 'A Comparison of Constant Volume and Con-

stant Pressure Scales for Hydrogen between 0° and 190° C.' The Committee on Radiation in a Magnetic Field also reported. The mathematicians of the Section met with the Educational Science Section in a joint discussion on the teaching of mathematics, opened by Professor J. Perry, F.R.S., of the Royal College of Science, South Kensington, and participated in by Professor A. R. Forsyth, F.R.S., of Cambridge, Professor A. W. Rücker, now principal of the University of London, Professor S. P. Thompson, F.R.S., of the same university, and others.

On Monday, the 16th, the Section again met in two departments—Mathematics and Physics. In the former, with Major MacMahon as chairman, there were papers by Professor G. Mittag-Leffler, of Stockholm, by Professor G. H. Darwin, F.R.S., by Professor A. G. Greenhill, F.R.S., and others, besides the report of the Committee on Tables of Certain Mathematical Functions. In the department of Physics, under Dr. Larmor, F.R.S., two interesting reports were presented, by Professor J. D. Everett, F.R.S., for the Committee on Underground Temperature, in which the temperatures recorded in the Calumet and Hecla mines were compared with the temperatures in the deepest shaft in the world, situated in Upper Silesia, and the sixth report of the Committee on Seismological Investigations, drawn up by Professor J. Milne, F.R.S., which stated that there were 36 seismological stations abroad and in Great Britain provided with seismographs recommended by the Committee. Among the physical papers, Dr. Crémieu offered one on 'Gravitation' and Dr. C. E. Guillaume, also of Paris, sent as a basis for discussion a proposition for a new unit of pressure, called the megadyne per square centimeter, which differs little from the present atmospheric unit. Considering the status of meteorology in Scotland, surprisingly few communications in this science were offered, and these suffered from being scattered through two sections. In the Physical meeting just mentioned, there were two suggestive papers by Mr. W. N. Shaw, F.R.S., secretary of the London Meteorological Office, and Mr. R. W. Cohen on 'The Seasonal Variation of Air Temperature in the British Isles and its Relation to Wind Direction,' and on 'The Effect of Sea Temperature on the Seasonal Variation of Air Temperature of the British Isles.' The next day the department of Meteorology met under Professor Turner, but, excepting the report of the Committee on the Ben Nevis Observatory, which was drawn up, as usual, by that Nestor among meteorologists, Dr. Alexander Buchan, F.R.S., the sole paper was by Mr. F. N. Denison, of Victoria, B.C., on 'The Seismograph as a Sensitive Barometer.' The author concluded that since the earth is depressed under areas of high barometric pressure and elevated under areas of low pressure, horizontal pendulums might warn the advent of great Atlantic storms before they reached the west coast of Ireland, but in the discussion that followed, doubt was expressed as to whether the observed effect had been assigned to the right cause. On account of the interest of the president of the Geographical Section, Dr. H. R. Mill, and of its recorder, Mr. H. N. Dickson, in meteorology, their Section also received three papers relating to this science, including one by Mr. Dickson on 'The Mean Temperature of the Atmosphere and the Causes of Glacial Periods.' 'The Systematic Exploration of the Atmosphere at Sea by Means of Kites,' illustrated by the first meteorological records high above the Atlantic, was discussed by the writer who, being a member of two sectional committees, was able to urge the grant of money appropriated for conducting meteorological researches with kites in Great Britain. Mr. W. N. Shaw exhibited to the Geographical Section a series of

twenty-three daily weather maps that were published in various parts of the world at the commencement of the twentieth century. With the exception of Africa, only a small portion of the north of which continent was mapped, South America and a part of eastern Asia, every part of the world has charted each day the weather conditions prevailing over it.

The communication that attracted the greatest popular interest in the Physical Section was by Lord Kelvin on 'The Absolute Amount of Gravitational Matter in any Large Volume of Interstellar Space.' This was a summary of his article in the *Philosophical Magazine* for August (see also *Nature* of October 24), the conclusion being that the matter contained in the universe could not be much more than a thousand million times the mass of the sun, the number of these bodies, estimated at one thousand million, occupying only twenty-seven thousandths of the proportion of space in the universe. Dr. Glazebrook then opened a discussion on optical glass and explained the assistance which the National Physical Laboratory might render in determining the properties it should possess and the best forms of lenses for various purposes. After the reading of several optical papers, Dr. W. J. S. Lockyer, assistant director of the Solar Physics Laboratory at South Kensington, spoke on the evidence of a thirty-five-year period in the occurrence of sunspots, which coincided with the climatic variations indicated by Professor Brückner, of Berne, and with the frequency of auroras and magnetic storms observed since 1833. The closing session of the Section on September 18 was mostly devoted to the magnetic papers. A report presented by the Committee on the Determination of Magnetic Force on board Ship related to the instruments supplied to the English antarctic ship *Discovery* and to the German antarctic ship *Gauss*. Captain E. W. Creak, F.R.S., described a new form of instrument for observing the magnetic dip and intensity at sea which was designed to replace Fox's apparatus. Lloyd's needles are applied to an instrument that can be used on a gimbal-table on board ship and the *Discovery* and the *Gauss* have been so fitted. The numerous communications to the Physical Section were of a high order and, considering the technical and special nature of many of them, the attendance was well maintained.

CHEMISTRY.

Professor Percy F. Franklin, F.R.S., Professor of Chemistry in the University of Birmingham, delivered the inaugural address, as president of the Section, on the subject of 'The Position of British Chemistry at the Dawn of the Twentieth Century.' He first pointed out that the history of British chemistry, as indeed of British science in general, was remarkable in that it was made up almost entirely of achievements which were the result of private enterprise. The foundation of University College, and other institutions for higher education, by private initiation, and without a particle of assistance from the public exchequer, was quite in keeping with the history of a country in which it was recognized that the Government did not lead, but only followed where it was drawn or propelled. There could be no doubt that the extended cultivation of scientific chemistry in Great Britain, which was such a noticeable feature of the concluding years of the nineteenth century, has been greatly assisted by the research scholarships open to all branches of science and paid with the income produced by the surplus from the Exhibition of 1851. Until recently it had been the feeling of a powerful majority that public money should only be spent in such a way as directly to benefit very large numbers, and in the case of educational funds, therefore, it was only their utilization for

the benefit of the masses that would be entertained. Now, in the matter of higher scientific education, at any rate, it was becoming more and more widely recognized that its starvation, through attention being exclusively directed to the low-level education of the masses, was defeating the very ends which this policy had in view. It was rapidly dawning upon many that 'the greatest Empire which the world has ever seen' could not be maintained unless Englishmen cast off insular prejudices and traditions and made a careful study of those points in which other nations were their superiors, with a view to intelligent adaptation and development, as distinguished from mere initiation, of their methods to particular needs of the British Isles. If the higher teaching of science was to be really encouraged, the first necessity was that this higher teaching should offer a sufficiently attractive career to the man of ambition as well as to the enthusiast. It was not reasonable to fix a definite stipend to a particular chair, and should the best man be required the best price must be paid for him, while, if the British universities were to keep abreast of those of other countries, the chair must be thrown open to all the world. The period of academic study should be extended from three years to five, and the migration of students from one university to another ought to be encouraged. Higher education and true universities were among the most potent factors in breaking down the hereditary stratification of society and in minimizing the advantages depending upon the accident of birth, so that, with the greatly enhanced facilities which must be provided for students without means, they should afford in the future, even more than they had done in the past, an avenue for the humblest boy of talent to that position which he was, by natural endowment and by his own exertion, best fitted to fill in the interests of the state. British chemical work at the dawn of the twentieth century is satisfactory in many ways, for while almost all the great problems are being worked at, some of the recent progress of chemical science is more or less specifically British, *e. g.*, the isolated labors of Dr. Perkin in the field of magnetic rotatory power; Sir William Crookes's exploration of the phenomena occurring in high vacua; the researches of Abney, Russell and Hartley on the absorption spectra of organic compounds; the investigations of Harold Dixon and Brereton Baker of the behavior of substances in the complete absence of moisture; the extension by Pope and Smiles of asymmetric atoms; the near approach to the absolute zero of temperature by Dewar; and those marvelous discoveries of Rayleigh and Ramsay which have not only introduced us to five new aerial elements, but have revealed the existence of a hitherto unknown type of matter, which is apparently incapable of entering into chemical combination at all.

After the usual vote of thanks, moved by Sir Henry Roscoe, F.R.S., and seconded by Dr. T. E. Thorpe, F.R.S., the Section proceeded to the reading and discussion of papers. Dr. W. T. Lawrence brought forward the question of duty-free alcohol for chemical laboratories. He pointed out that workers in England were placed at a great disadvantage in comparison with workers in Continental laboratories, owing to the charge made on alcohol which was required in very large quantities in research. Abroad, when duties were exacted, they were remitted in the case of chemical laboratories so as not to impede the progress of the work of investigation. It was stated by others that some researches had been stopped half-way on account of this extra expense. Professor A. Michael, of Tufts College, Mass., explained that in the United States the duties were remitted when application was duly

made by the president of an educational institute. As a result of the discussion a committee was appointed to take what steps it could to procure duty-free alcohol and ether for chemical research. Dr. A. G. Green read a paper on 'The Decadence of the Coal Tar Industry in Great Britain and its Growth in Germany' of which an abstract was given on page 663 of SCIENCE. The report of the Committee on preparing a new Series of Wave-length Tables of the Spectra of the Elements was presented. The next day, after papers by Professor A. Brown on 'Enzyme Action,' and by Professor W. Marckwald, of Berlin, on 'Radium,' with demonstrations, the Section resolved itself into parts, one, under the president, considering sanitary and allied matters; the other, under Sir William Roberts-Austen, F.R.S., hearing metallurgical papers. In the former subsection, Professor E. A. Letts read a paper by himself and Mr. R. F. Blake on 'The Chemical and Biological Changes occurring during the Treatment of Sewage by the so-called Bacteria Beds,' in which it was pointed out that in the bacterial treatment of sewage in contact beds the organic nitrogen in the crude sewage was not all converted into the oxidized form of nitrate, this loss being partially due to the formation of free nitrogen, which was either evolved as gas or carried away dissolved in the effluent, and partly due to nitrogen absorbed into the tissues of animals and plants that feed on the sewage. Dr. S. Rideal in the next paper pointed out that the loss of nitrogen was caused in part by a black humus substance, allied to peat, which he had found was formed in all the present methods of bacterial process. This substance contained seven per cent. of nitrogen and was so stable that it did not decompose or give rise to smell, even if it was broken. Dr. Rideal also contributed a paper on 'Sulphuric Acid as a Typhoid Disinfectant,' in which he said that the outbreak of enteric fever among the troops in South Africa had led Dr. Porter and himself to try to find a chemical salt that could be added to infected water by soldiers on the march and would insure the death of the typhoid germ, if present. Such a salt is sodium bisulphate, and a gram to the pint, after fifteen minutes, purified the water, while four grams of sulphuric acid to the gallon freed sewage or drainage water from typhoid organisms. Mr. Wm. Ackroyd read a paper on 'The Inverse Relation of Chlorine to Rainfall,' in which he showed that when daily estimations of the amount of chlorine were made it clearly appeared that minimum amounts of rainfall were marked by maximum amounts of chlorine contents and *vice versa*. Mr. Ackroyd also detailed the results of his investigation of the distribution of chlorine in Yorkshire. A report was made by the Committee on the Relation between the Absorption Spectra and Chemical Constitution of Organic Substances.

Among the papers before the Metallurgical subsection, one of the most interesting was on 'The Minute Structure of Metals,' by Mr. G. T. Beilby, from which it appeared that the microscopical examination of metallic surfaces, produced in various ways, showed that the metal substance appeared in them as minute granules or scales, or as a transparent glass-like substance. The persistence of these minute scales under all kinds of mechanical and thermal treatment, the remarkable uniformity of their size and appearance in metals of all the leading groups, their disappearance into the transparent form and their reappearance again, apparently unchanged in size or otherwise, all these seemed to afford fair ground for the conjecture that they were in some way definite units in the structure of metals. Mr. Beilby also submitted a joint paper by

himself and Professor G. G. Henderson on 'The Action of Ammonia on Metals at High Temperatures,' which stated that the physical effect of the treatment in every case was to disintegrate the metals completely, while a large proportion of the ammonia was resolved into its elements. Three papers on aluminum and its alloys, together with the report of the Committee on the Nature of Alloys, were presented.

The papers on organic chemistry, to which September 16 was devoted, drew but a small audience, owing to their highly technical nature. The reports of the Committees on Isometric Napthalene Derivatives and on Isomorphous Derivatives of Benzene were taken as read. Professor A. Michael, of Tufts College, contributed three papers, one being on 'The Genesis of Matter,' in which he assumed that at the birth of matter there were two forms of 'protyle' corpuscles endowed with opposite polarity and only two forces—gravitation and chemical affinity—the temperature being near the absolute zero. Gravitation acted on these corpuscles, and when they came within the sphere of chemical affinity they united, converting part of their chemical energy into heat. It was probable that the non-metals in the genesis of matter would be first formed, and that as the temperature decreased the metallic elements began to form. At the next meeting of the Section the papers on general and physical chemistry were so numerous that it was necessary strictly to limit the time of each speaker. Professor J. Sakurai, of Tokio, speaking on 'Some Points in Chemical Education,' said that chemical education, as at present carried on, was inefficient and unsatisfactory. Chemical education was a sound course for those who would become chemists or for those who applied that science in special directions, but it was no less important for its educational value in secondary schools. Nevertheless, modern chemistry was still taught largely in the same dry and descriptive way as in the old days. He deprecated the term 'physical chemistry' as misleading and suggested that 'general chemistry' be used in its stead. Chemical laboratories in universities and colleges, he thought, should be institutions which contributed to the sum total of the knowledge in which men were trained and not mere workshops for apprentices. In the discussion that followed it was the general opinion that a thorough training in analysis should precede research work. Mr. W. Thomson read a practical paper on the 'Detection and Estimation of Arsenic in Beer and Articles of Food,' and Dr. E. F. Armstrong discussed 'The Equilibrium Law as Applied to Salt Separation and to the Formation of Oceanic Salt Deposits.' Its application to the formation of deposits, of potash and other salts, formed by the gradual drying up of ancient seas, is of interest and from a model, representing the successive changes observed on concentration of solutions containing several inorganic salts, it was possible to forecast the order in which salts would separate on concentration, and also the relative amounts deposited at any stage. The Committee on the Bibliography of Spectroscopy reported. At the closing session of the Section Dr. J. Gibson read a paper on 'The Electrolytic Conductivity of Halogen Acid Solutions,' in which he showed that there was a marked difference in the chemical behavior of the solutions of acids, according as the concentrations were above or below the concentrations corresponding to their respective maximal specific conductivities. Mr. P. J. Hartog, in describing 'The Flame Coloration and Spectrum of the Nickel Compounds,' said that nickel acetate produced an evanescent purple tinge and a persistent red coloration in the Bunsen flame. Professor Smithells remarked that, although experiments with nickel had been made for

years this property had not been observed, and the coloration perhaps might not be due to nickel. After papers by Dr. Farmer, on 'The Methods of Determining the Hydrolytic Dissociation of Salts, and by Dr. J. S. Patterson, on 'The Influence of Solvents on the Rotation of Optically Active Compounds,' the meeting terminated, having been less well attended, in spite of the interesting papers, than was the case at Bradford last year.

ENGINEERING.

This Section suffered severely in coming immediately after the assembling at Glasgow of the important International Engineering Congress, the Congress of Naval Architects and the Electricians' Association, all of which detracted from both papers and members. As a consequence, not a single paper on marine engineering, and only two papers pertaining to electricity were offered to the Section this year.

The president, Col. R. E. Crompton, M.Inst.C.E., in his address discussed first some of the interesting problems presented by recent development in means of locomotion on land, which demand the best thought, not only of our engineers, but of every one interested in the improvement in the means of traveling and in the more rapid transportation of goods. During the past few years a great improvement in the speed of trains and in the comfort of passengers on the American and Continental railways has been made, and while it appears that England has now been beaten in the matter of extreme speed on railways, it is probable that the English railways still provide a larger number of rapid trains than do either the American, German or French. The speed limit of railways of the present system of construction is reached at about sixty-five or seventy miles an hour, and it is improbable that anything greatly in excess of seventy miles an hour will be attained until an entirely new system of construction is instituted. The high speed service contemplated intends to obtain speed exceeding one hundred miles an hour by providing electrical means of haulage sufficient to propel light trains consisting of a single or, at most, a few cars run at short intervals of time. In the United Kingdom there are only a few journeys of sufficient length to make saving of time of great importance, but the case is far different in America and on the Continent where the business centers are much farther apart, and this topographical question would cause our English engineers to be at a disadvantage. A most important problem in locomotion is that caused by the congestion of street traffic in towns, and although the provision of electric tramways is undoubtedly an economical means of carrying passengers, yet these tramways could not be laid in existing thoroughfares without considerably reducing the total road-carrying capacity at times of heavy pressure of traffic, and so both for ordinary and pleasure transportation it appears probable that a motor-car service carried out on well-made roads would compete favorably with, and in many ways might be preferable to, tramway service. One of the topics that has been most strongly discussed during the past year is the position which Great Britain holds, relatively to other countries, as regards supremacy in engineering matters. The chief difference between the manufacturer here and the manufacturer in America is that the latter invariably makes goods in large quantities to standard patterns, which is much less the case in England. Many years ago, Sir Joseph Whitworth impressed on the world the importance in mechanical engineering of extreme accuracy and of securing the accurate fit and interchangeability of parts by standard gauges, but these ideas have not been acted upon to the extent that they should. Up to the present time the

Board of Trade has dealt with the simple standards of weight, capacity and length, but in other countries national standardizing laboratories have been provided. At last, through the exertion of the council of the Royal Society, the British Government has been moved to give a grant in aid and to cooperate with the Royal Society to establish a National Physical Laboratory. The vote of thanks to Col. Crompton for his address was moved by Sir Alexander Binnie and seconded by Sir Frederick Bramwell.

Mr. D. H. Morton, M.Inst.C.E., spoke on 'The Mechanical Exhibits of the Glasgow Exhibition,' which he said were, in general, disappointing, because in many departments the international character to which the Exhibition, as a whole, laid claim, was entirely wanting; because some of the most important developments in recent years were illustrated inadequately or not at all, and because the Exhibition failed to give any full idea of the magnitude and the variety of those enterprises which have made the city of Glasgow, with its surroundings within a radius of thirty miles, one of the world's great centers in metallurgy, mechanical engineering and shipbuilding. The collection of ship models historical and contemporary, was probably the finest demonstration of Clyde naval architecture ever seen, although marine engineering was so inadequately represented elsewhere. Nevertheless, the dominant Exhibits were the trophies in steel, and the exhibition might, indeed, be said to mark the triumph of steel, and particularly of cast steel. Mr. John R. Wigham explained a method of employing petroleum as an illuminant for beacons and buoys, to give a continuous light for a month or longer without any attention whatever. He exhibited also a 'New Scintillating Lighthouse Light,' by which the sailor was not deprived of the benefit of the powerful flash of the revolving lense, and yet did not have to pick it up at intervals, for this light is continually visible, the lenses being so placed with regard to each other and so revolved that the impression of the flash of one beam remains on the retina of the observer's eye till that of the succeeding beam takes its place, the practical effect produced being a continuously visible scintillating light. Mr. J. E. Petavel described a recording manometer for high-pressure gas explosions, in which elastic compression of metal replaces the spring of the ordinary indicator, a movement of a thousandth of an inch, corresponding to a pressure of 1,200 pounds per square inch, being shown by a ray of light deflected on to a recording cylinder. On the following day Mr. Norman D. MacDonald, of Edinburgh, read a comprehensive and interesting paper on 'Railway Rolling Stock, Present and Future.' Outside Great Britain it appeared settled that the compound locomotive would be the engine of the future. The boiler pressures, both in America and on the Continent, are much higher than in England, and for English roads the American type of engine, with equalizing levers and water-tube grate, offered advantages. In the discussion of the paper the progressive character of railway engineering in the United States was attributed to the attention paid by American universities to the testing of locomotives, and also to the good work done by the various railway clubs in spreading the knowledge of locomotive practice among young engineers. Mr. P. Bunau-Varilla, formerly engineer-in-chief of the Panama Canal, spoke on the relative advantages of the Nicaraguan and Panama routes for a canal from the Atlantic to the Pacific, favoring the latter on account of the masonry dam, which, with the locks, must be built and maintained in a country subject to frequent earthquakes, if the former be chosen. Moreover, ships would there encounter violent gales, strong

river currents, constant changes of depth, and many curves of short radius.

Monday is usually devoted to electrical engineering but, as already remarked, there were but two papers approaching that character this year. Mr. Killingworth Hedges contributed a paper on 'The Protection of Public Buildings from Lightning,' remarking that in 1888 the subject had been discussed jointly by the Physicists and Engineers of the Association, but that there had been no official report as to the effect of lightning strokes upon buildings protected by conductors since the Lightning Rod Conference of 1882. In the discussion it was said that architects could not be expected to pay more attention to protection of buildings from lightning until engineers had definitely decided what practice should be followed, there being at present many conflicting views. 'The Commercial Importance of Aluminium' and 'Aluminum as a Fuel,' were discussed respectively by Professor E. Wilson and Sir Roberts-Austen, F.R.S., the former considering chiefly its advantages as an electrical conductor. Mr. J. Dillon described a method of recording soundings by photography, for the use of engineers; Dr. Vaughan Cornish discussed the height and length of waves observed at sea, and Mr. R. L. Jack showed pictures of native bridges in Western China.

Two reports of committees were presented to this Section. Professor H. S. Hele-Shaw made a preliminary report for the Committee on Resistance of Road Vehicles to Traction, from which it appeared that some work had been done with a motor-car and experiments had been made on an artificial track so as to test the resistance of various materials. Mr. W. H. Price reported for the Committee on the Small Screw Gauge that, while it had been recommended last year that the thread of the British Association screw-gauge should be altered in certain particulars, and the proposals had attracted much attention, yet so far the recommendations had had no practical results. Professor G. Forbes explained a portable folding range-finder, for use with infantry, based on the instrument of Adie and utilizing stereoscopic vision. After papers by Mr. Mark Barr, describing his ingenious machines for engraving the matrices used in type-founding, by Mr. C. R Garrard, on 'Recent Development of Chain Driving,' by Mr. T. A. Hearson, on 'Measurement of the Hardness of Materials by Indentation by a Steel Sphere,' by Mr. E. T. Edwards, on 'The Critical Point in Rolled Steel Joists' and by Mr. J. W. Thomas, on 'Air Currents in Churches' the Section adjourned a day before the other sections. Notwithstanding the paucity of papers, they were of fair quality and covered a wide range of subjects.

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SCIENTIFIC BOOKS.

Smokeless Powder, Nitro-cellulose and Theory of the Cellulose Molecule. By JOHN B. BERNADOU, Lieutenant U. S. Navy. N. Y., John Wiley & Sons. 1901.

This work consists of eighty pages of new matter and of one hundred and thirteen pages of translation and reprints. The newly presented portion treats of: (1) Origin of the cellulose nitrates; the names by which they have been sometimes designated; and the meanings that the author gives to the terms he employs; (2) to 'the earlier views as to nitro-cellulose composition and constitution'; (3) to 'the conception of progression in relation to composition and constitution'; (4) to 'solutions of nitro-cellulose' and 'theory of the cellulose molecule.' It will be observed that in this brief space the author has set for himself a most ambitious program, especially as he applies himself to the solution of one of the unsolved problems of chemistry and one which chemists have regarded as presenting the most profound difficulties. Naturally those chemists into whose hands this book may come would turn at once